News release

Surface and upper-air temperature trends: is there really a discrepancy?

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A long-held claim used by climate sceptics has been countered by new research out today. This claim, that there is an apparent discrepancy between strong warming at the Earth's surface and weak warming in the lowest part of the atmosphere, thus undermining theories on global warming, has now been seriously challenged. Research shows that there are clear explanations for what the observations are showing and that the thrust of climate change science is entirely valid.

One of the key unresolved issues in connecting recent climate change with human activity has been the large difference between estimates of temperature trends above the Earth's surface from observations and models. New research shows that the estimates from observations are highly uncertain. Through comparing new observational estimates to a large number of the latest climate models, there is no longer evidence for any fundamental discrepancy.

At the time of the last assessment of the Intergovernmental Panel on Climate Change (2001), the best evidence from observations indicated that the Earth's surface had warmed rapidly since 1979, whilst the air in the lower 8 km of the atmosphere above the surface had not. This directly contradicted climate models which simulated larger warming aloft, rather than at the surface. These differences were most marked in the tropics.

To investigate this apparent discrepancy, intensive research has been done to determine exactly how temperatures have evolved aloft. This work has yielded a number of new data sets, each produced with different but plausible approaches. Differences between data sets are as large as the expected trend from human influences. This range of estimates no longer precludes a warming aloft at least as large as that reported at the surface.

New research led by the Met Office's Hadley Centre argues that the choices made by each research group in constructing climate data sets can have a significant impact. The key problem is that methods used for observing the atmosphere have changed considerably over the years. The satellite and balloon-based systems used were designed to provide the best possible snapshot of the global weather at any time, rather than to monitor long-term changes. Improvements, while undoubtedly benefiting this primary monitoring aim, lead to significant biases which corrupt the true climate change signal. There is no definitive 'how to' guide for removing these biases and constructing a truly homogeneous climate record. The new research shows clearly that the choices made in homogenising the data have a particularly strong effect on estimates of climate change.

These findings are brought into sharp focus in a paper to appear in *Science Express* (Science's advanced online publication) this week. Santer et al. compare tropical predictions from a range of climate models with the new suite of observational estimates. Hadley Centre authors were prominently involved with this research, which compares simulations from 19 of the world's climate models with four different upper-air data sets (two from satellites and two from weather balloons).

Within the tropics, simple theory predicts that any increase in surface temperature should be accompanied by an even larger increase aloft. All the climate models considered in the Santer et al. study behave in this way, whether looking at individual months or from one decade to another. Given the differences between the models, the degree of agreement amongst them is quite remarkable. All observed data sets also exhibit this behaviour on short timescales (months to years). However, on long timescales, only one of the four upper-air data sets gives amplification aloft, with others implying damping of surface temperature changes.

There are two potential explanations for this result. One is that in the 'real world' tropics, different processes control the link between surface and upper-air temperatures on short and long timescales, and models cannot capture such subtle behaviour. An alternative explanation is that at least some of the observational records retain large biases which preclude their use for long-term trend analysis in the tropics. This second interpretation implies that there is no longer any fundamental discrepancy between modelled and observed temperature changes in the tropics.

Although recent analyses have not entirely resolved these issues, they have gone a long way to highlighting where further research efforts are required.

More about the Hadley Centre

Notes:
The paper will appear in *Science Express* on 11 August 2005.

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